The Two Converging Paths of Social Marketing and Behavioural Economics: A Systematic Review and Narrative Synthesis of Their Effect on Physical Activity and Nutrition Behaviours in Children.

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ABSTRACT

BACKGROUND: Behavioural economics and social marketing have potential to influence health behaviours in children, but there has been no systematic review considering the combined impact of these strategies. The aim of this research is to conduct a systematic review and narrative synthesis of both behavioural economics and social marketing strategies in relation to influencing children's nutritional and physical activity behaviours. METHOD: Two pre-registered systematic reviews were conducted and combined adhering to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines and in total 51 studies were included. RESULTS: 35 studies reported behaviour change, 2 reported no behaviour change, and the remaining 14 had more descriptive outcomes exploring the implementation of the interventions. Studies investigated only nutritional outcomes (n=37), only physical activity outcomes (n=9), or both nutritional and physical activity outcomes (n=5). The findings demonstrated the links between both behavioural economics and social marketing, particularly in influencing the behaviours of children. Three key methods were identified for influencing behaviour: using a character (n=3), raising awareness (n=19), and using media/technology (n=11). These were often used in combination (n=18). CONCLUSION: The study highlights how both behavioural economics and social marketing have been used positively, for example in promoting physical activity engagement; but also negatively, for example in the promotion of junk food. It is suggested that future interventions adopt the use of both strategies in a holistic way to best develop, execute and evaluate their interventions to positively influence health behaviours in children.

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1.0 BACKGROUND

The World Health Organisation (WHO) [1] and the European Commission [2] advocate the importance of promoting positive health behaviours in children [3]. The early development of healthy practices, including partaking in physical activity and following a nutritionally balanced diet may play a prophylactic role in health outcomes [4]. In addition, other modifiable lifestyle behaviours that impact on child body weight, including sufficient sleep and screen exposure time [5] are important to consider as obesity is one of the most significant and prevalent health risks for children worldwide [6].

Physical activity is considered an essential part of a child's overall health and wellbeing [7]. The WHO [8] recommend that children should engage in at least 60 minutes of moderate to vigorous intensity physical activity (MVPA) every day, however it is consistently reported that few children meet these recommendations [9,10]. Participating in physical activity at any age elicits health benefits; in children physical activity aids healthy growth and development, optimises cardiometabolic function, and aids in the prevention of multiple chronic diseases. Recent research has found a decline in MVPA from early childhood [11,12] and as behaviours established at this early stage of life are likely to track into adulthood [13] it is imperative that positive health behaviours, including engaging in MVPA, are established early on if the goal is to influence longer term behaviours.

In addition to physical activity, a nutritionally balanced diet is a key contributing factor to overall health. Children are aware of the role of healthy nutrition at an early age [4]. Despite child awareness of the importance of a nutritionally balanced diet at a young age, under-consumption of fruit and vegetables and over-consumption of nutritionally poor "junk food" is common among children [14,15]. Physical activity, and the adoption of a healthy diet are two main health related variables that substantially effect a child's health, and as such there has been a lot of research around promoting these positive health behaviours. Much of this research has focused upon how to influence them.

One strategy to influence behaviour that has become popular is the use of behavioural economics. Its recent increase in popularity may be attributed to its conceptual appeal, and its potential to offer low cost unobtrusive solutions to many of the serious problems facing our society including overeating [16]. Behavioural economics exploits the psychological underpinning of human behaviour in terms of predicting decision making, ultimately influencing the decision in a positive way whilst still ensuring freedom of choice. In terms of physical activity interventions, behavioural economists aim to understand the often complex decision to engage in physical activity [17]. One example of a strategy used is nudging. The theory behind this argues that our decision making is often governed by unconscious cognitive impulses like habit, fear, and bias, and therefore is inherently irrational [18]. This means that we may therefore be susceptible to manipulation whereby suitable interventions can influence the decision-making environment to 'nudge' individuals to make better choices [18]. The behavioural insights team in the UK is responsible for incorporating behavioural economics into policy making, and they have developed an acronym to show the key lessons of the approach, MINDSPACE [19], this can be seen in table 1.

Table 1: MINDSPACE - Adapted from Matjasko et al., 2016 [19]

Letter	Meaning
M	Messenger, we are influenced by who conveys the information
I	Incentives, people respond to incentives and in particular are thought to exhibit loss aversion
N	Norms, people are influenced by their perceptions of what others do
D	Defaults, people are influenced by default options
S	Salience, people are particularly influenced by incentives that are visible and new
P	Priming, people can be influenced by subconscious cues
A	Affect, emotions influence decisions
C	Commitment, people with time inconsistent preferences may seek pre-commitment devices
E	Ego, people prefer to act in ways that make them feel better about themselves.

Behavioural economics has been, so far, the most influential behavioural science in policy-making, [20]. Social marketing on the other hand is often thought of as a separate approach, yet uses behavioural economic strategies to promote behaviour change [21] and is part of the growing popularity of using behavioural economics strategies in health policy. However, this fact has failed to be sufficiently acknowledged [20]. Social marketing can be defined as the use of marketing principles and techniques to influence a target audience to voluntarily accept, reject, modify, or abandon a behaviour for the benefit of individuals, groups, or society as a whole [22]. In the majority of cases social marketing wants to influence an audience to either: accept a new behaviour, reject a potential behaviour, modify a current behaviour, or abandon an old behaviour [22]. Social marketing typically uses the '4 P' approach: product, price, place, and promotion [23]. Firstly, the product does not have to be a physical offering [24] but can relate to a behaviour or practice. Price refers to what needs to be done to obtain the product. Place is about how the product reaches the consumer. Finally, promotion signifies the use of advertising, public relations, promotions, media advocacy, personal selling, and entertainment vehicles [24].

It has been suggested that both behavioural economics and social marketing strategies are similar; indeed, the relationship was described by Dessart and Van Bavel as "two converging paths" and that, if combined, both disciplines could further inform policy making in a way that only one strategy alone could not. The integration of social marketing to the application of behavioural economics strategies should be considered due to its potential to influence behaviour [20]. One example of a strategy that uses both behavioural economics and social marketing is the work by Change4Life developed by the UK government. Change4Life is a social marketing campaign designed to steer individuals towards making healthier lifestyle choices [18]. One aspect of the program involves getting people to sign up so they can receive email *nudges* to help towards healthier behaviours, using a key strategy of behavioural economics. In terms of social marking, it has a clear brand and uses TV adverts to deliver its message. Recent work by Change4Life targeted specifically at children, called the 10 minutes shake ups, has adopted the use of popular Disney characters and uses them to promote 10 minutes of exercise, aimed to help towards meeting their daily recommendations [25]. Not only does this strategy use popular branded characters related to the *promotion* stage of an intervention in terms of social marketing, but it relates to the M in the MINDSPACE acronym, suggesting that people are heavily influenced by who conveys the information.

Change4Life is an example of how social marketing and behavioural economics approaches can be combined, as suggested by Dessart and Van Bavel to create a potentially effective health-based behaviour intervention. Despite the potential benefits to using either of these strategies to influence behaviour, and some evidence from successful interventions, no systematic reviews to our knowledge have been conducted yet into the way that these strategies can be used to influence health related

behaviours in children. This could provide key evidence from past research to help inform future health-based interventions development, evaluation, and implementation. As such the aim of this research is to conduct a systematic review and narrative synthesis of both behavioural economics and social marketing strategies in relation to influencing children's nutritional and physical activity behaviours.

2.0 METHOD

The method is split into two separate parts. The original review was conducted in January 2019 and focused primarily on social marketing. Another review was planned to look at behavioural economics separately, however once both searches had been completed the overlap between the studies found was apparent and it was then decided that the two separate reviews would be merged into one, encompassing both strategies. This is described further in the following section.

Part 1

The review was registered with PROSPERO (CRD42019118679) in January 2019 and adhered to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines. Four databases were searched in January 2019 PubMed, Science Direct, SPORTDiscus and Web of Science. The focus of the search was to identify those studies that employed a social marketing strategy for the aim of effecting either nutritional or physical activity behaviours in children. Multiple key words were used (refer to the registered protocol) which were agreed *a priori* and chosen as they linked to the research question. Studies were included up to January 2019 with no other date limits applied. The inclusion criteria were that studies had to be in the English language and include children up to and including 12 years of age and research either nutritional of physical activity behaviours. Studies were included when the age range of children started below 12 years even if the higher age group exceeded 12 years old. Studies were excluded if they did not contain original research, were review articles, books, or studies that were not peer reviewed. No other exclusions based on study design were employed and studies including any healthy or unhealthy lifestyle behaviours were considered.

Figure 1 illustrates the systematic review process for the social marketing research. The research was screened using an online tool, Covidence. All 7475 references were imported and duplicates were removed (2060) leaving 5429 titles that were screened. Of these screened titles 5193 were marked irrelevant which left 236 to be full text screened. Two researchers (EBS and ST) screened the studies with any disagreements being resolved through discussion and, if needed, the opinion of a third researcher. At this stage, 195 studies were removed for a variety of reasons including being research on the wrong population, or not providing original research; this resulted in 43 studies included in the review.

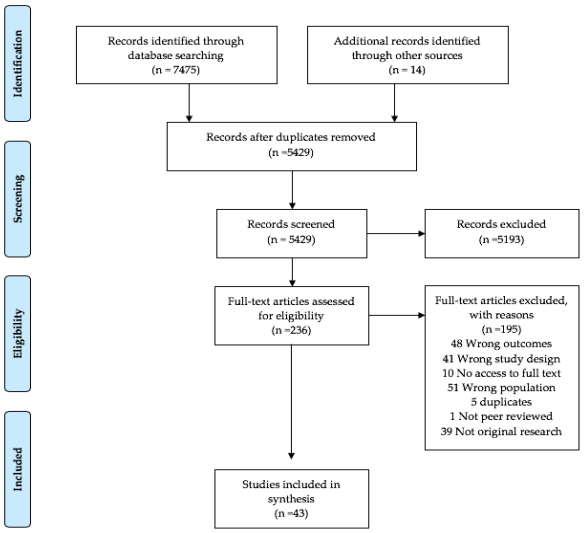

Figure 1: Social Marketing PRISMA

The second review was conducted in January 2020 and focused primarily on behavioural economics strategies and again the review adhered to the PRISMA guidelines. The same databases and inclusion/exclusion criteria were used to part 1, however the focus of the search was to identify those studies that employed a behavioural economics strategy for the aim of effecting either nutritional or physical activity behaviours in children. Therefore, different multiple key words were used (refer to the registered protocol) which were agreed *a priori* and chosen as they linked to the research question. Studies were included up to January 2020 with no other date limits applied.

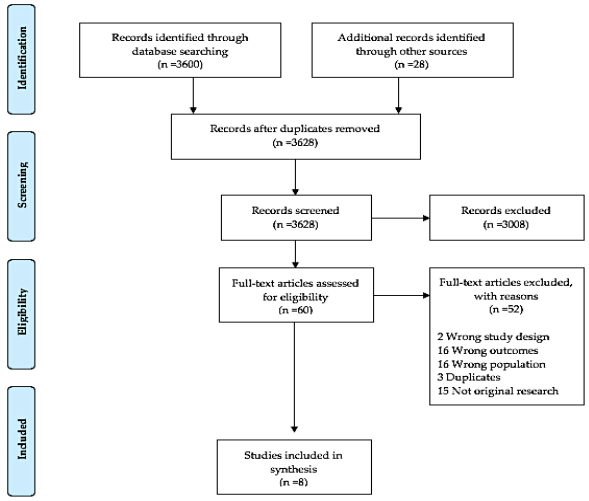

Figure 2: Behavioural Economics PRISMA

Figure 2 illustrates the systematic review process for the behavioural economics research. The research was analysed using an online tool, Abstrackr. After all 3628 references were imported and duplicates were removed (560) 3068 titles were screened, 3008 were marked irrelevant this left 60 to be full text screened. At this stage 52 were removed for a variety of reasons including being research on the wrong population, or not providing original research; this resulted in 8 studies included in the review. Two researchers (EBS and ST) screened the studies with any disagreements being resolved through discussion and, if needed, the opinion of a third researcher.

Part 3

After the two separate reviews were conducted it was decided due to their similarity, cross over, and literature suggesting they are strategies that should be combined to further inform policy making, the reviews were merged into one larger review. In January 2020 the first review was updated to include the up to date research from the preceding 12 months since the first literature search took place. The original pre-registration record on PROSPERO from January 2019 (CRD42019118679) was updated in January 2020 to reflect this and the final PRISMA diagram can be seen in figure 3.

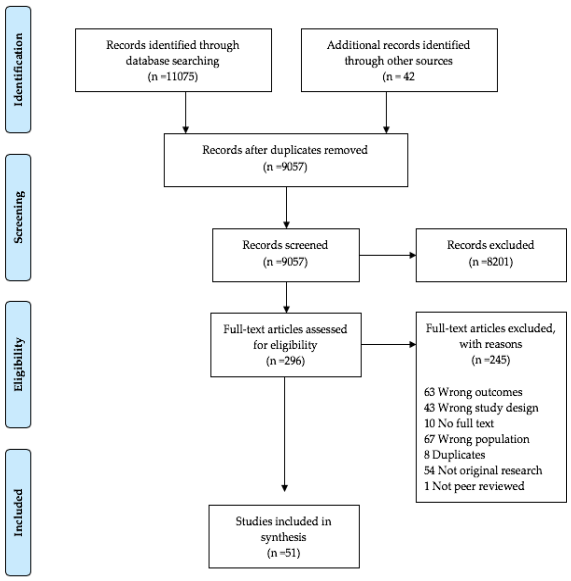

Figure 3: Joint PRISMA

Methodological quality

The Mixed Methods Appraisal Tool (MMAT) was used to assess the methodological quality of the included studies [26]. The MMAT uses 19 quality criteria relating to the 5 methodological designs: qualitative, quantitative randomised controlled trials, quantitative non randomised controlled, quantitative observational descriptive, and mixed methods. This was done by two researchers (EBS and JP), however if there were any disagreements these were settled by a third researcher. High quality studies were considered to be those which score 80% or higher.

Grouping the data

The studies were also grouped into key concept areas depending on their method of influencing behaviour. These were:

1. Characters – those studies that used a character and/or celebrity as an influencer
2. Awareness – those studies that aimed to raise awareness through branding, prompts, visual ques or nudges
3. Media/technology – those studies that incorporated the media (TV shows, films e.c.t) advertising commercials and technology

These three concepts were chosen *post hoc* as they were common throughout all the papers, transcended the definitions of both social marketing and behavioural economics, and allowed for a more holistic analysis of the papers. The grouping was an inductive process based on extracting the main techniques from the literature.

3.0 RESULTS

51 studies were included in the review. Studies investigated only nutritional based outcomes (n=37), only physical activity based outcomes (n=9), or both nutritional and physical activity outcomes (n=5). Studies we conducted in North America (n=28), Europe (n=12), Australasia (n=7), South America (n=3), and Asia (n=2). Thirty five studies had a sample size of >250 participants, 9 had a sample of between 250-999 participants, and 7 included a sample of <1000. There was research focused on both promoting a positive health behaviour (n=25) and research promoting a negative health behaviour

(n=26). Table 2 presents a summary of all the included papers for the review along with some key information for each. All papers were published in the 2000's, with 22% of the included papers were published in 2019/2020. In total 35 papers (69%) reported a behaviour change due to the intervention, with only 2 papers (4%) reporting no behaviour change. Examples of behaviour change variables included consumption behaviours, BMI z-scores and physical activity levels. The remaining 14 papers (27%) were focused more on exploring the implementation of the intervention and thus had different outcome outcomes (these are marked N/A in the table under the column behaviour change).

Nutrition

There were 37 studies examining nutrition based outcomes, with an mean quality score of 75% (range: 60-100%) and an average sample size of 556 ranging from 27-11820. Two of the studies were qualitative [27,28] with a mean quality score 100%. Seventeen were quantitative descriptive [29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45] with a mean quality score 75%. Five were quantitative non-randomised [46,47,48,49,50] with a mean quality score 84%. Twelve were quantitative randomised [51,52,53,54,55,56,57,58,59,60,61,62] with a mean quality score 65% and one was a quantitative randomised cross over study [63] with a mean quality score 80%. Eleven of these papers were for a positive health related behaviour [28,29,30,31,38,48,59,60,61,62,63] and the remaining 26 were for a negative health behaviour [32,33,34,35,36,39,40,41,42,43,44,45,46,47, 49, 50, 51,52,53,54,55,56,57,58,27].

Physical activity

There were 9 studies examining physical activity based outcomes, with a mean quality score of 78% (range: 60-100%) and an average sample of 3331 ranging from 12-20818. Two studies were qualitative [64,65] with a mean quality score 100%. Four were quantitative descriptive [66,67,68,69] with a mean quality score of 70%. One was quantitative non-randomised [70] with a mean quality score 80%. One was quantitative randomised [71] with a mean score 60%, and one was mixed convergent [72] with a mean quality score 80%. All of the papers were for a positive health behaviour [72,64,65,66, 67,68, 69, 70,71].

Nutrition and Physical Activity

There were 5 studies examining nutrition and physical activity based outcomes combined, with a mean quality score of 60% (range 0-100%) and an average sample of 1015 ranging from 133-4363. One study was qualitative [73] with a mean score 100%. Two were quantitative non-randomised [74,75] with a mean score of 40%, and two were quantitative randomised [76,77] with a mean score 60%. All of the papers were for a positive health behaviour [73,74,75,76,77].

***Insert table 2 here**

4.0 DISCUSSION

The review identified studies that demonstrated the impact that both social marketing and behavioural economics has on influencing the health behaviour of children. The narrative synthesis will explore how both behavioural economics and social marketing strategies have been used holistically, positioning them as two converging paths towards behaviour change. The research will be discussed in relation to the three key concepts that were identified which transcend the definitions of both strategies: awareness, characters, and media/technology. A main finding from this review has been the overwhelming effect that these strategies have on behaviour change, of the 37 studies that included an aspect of behaviour change as an outcome, 35 (95%) of them reported a change in behaviour. This demonstrates the influence that these strategies have over children's behaviour.

Awareness

Eighteen studies used only awareness methods [29,28,75,74,39,34,36,54,27,45,53,59,60,61,76,73,69,71] with a mean quality score of 73.3%. The awareness studies were those that aimed to raise awareness through branding, prompts, visual ques, or nudges. Nudges are a common method and were used by three of the papers included in this review. One of these studies was conducted by Miller et al., (2016) [60] in 71 students using a difference in design on pre-ordering of lunches. The study examined the use of nudges on food ordering; a child would place their preferred lunch order in advance using an online system and if this was deemed *unhealthy* they were given the message "your meal does not look like a balanced meal", advice on making this meal healthier, and offered a chance to amend their chosen items. If the child then preceded to amend their order to a healthier one they were then shown an image of a smiley face and a statement saying that they have ordered a balanced meal; this being positive reinforcement. This is an example of how the researchers were nudging to make the children aware of their behaviours and raising their awareness in the aim of promoting a healthier option. Indeed, students who pre-ordered and received nudges were more likely (51.4%) to choose fruits, vegetables, and low fat milk than those not receiving nudges.

Another example of raising awareness is in using visual prompts and posters, these were common methods in many of the studies included in the review. For example, one study employing surveys and interviews with parents (n=59) and children (n=58), aimed to promote healthier children's meals at both quick service and full service restaurants [29]. Methods to promote this included trained servers who would prompt families with children to try the healthier menus, and signs displayed in the restaurants promoting the heathier options available. This links into the 4 P's of social marketing, the *product* was the healthier meal, the *price* was the fact that you had to sacrifice the unhealthier meal, the *place* was on the walls and placemats at the restaurant and the *promotion* was the use of posters and interestingly also characters. As well as the posters there were also "Super Crew" characters and toys to help influence the behaviour of the children. Behavioural economics tells us that people are influenced by who delivers the message, so using characters to do this may be influential, especially in children. This demonstrates how both social marketing and behavioural economics were used in unison to influence a child's behaviour. Although, it was noted that the major influencers of children's meal choices were taste and habit, with both parents and children feeding into decisions. As such it is argued that emphasis of these points through use of social marketing approaches may be an approach to explore in shifting children towards positive nutritional behaviours. This also is an example of a study which used both awareness and characters, of which three studies included in this review did this [70,48,31] with a mean quality score 73.3%. This included research that was a home based physical activity intervention for girls which successfully incorporated a fictional role model to increase their physical activity levels [70]. A study using characters on children's food wrapping which demonstrated the influence that these characters have on preference [48] and a pilot study investigating ways in which healthy children's meals can be promoted at restaurants [31].

Another form of raising awareness that was popular was using a brand. An intervention that focused heavily around the use of a brand was the VERB™ campaign which has been investigated in four of the included studies of this review [73,74,75,76,77]. The campaign was launched in in 2002 and used social marketing principles in an effort to increase the physical activity levels of children aged 9-13 years old [64] and the branding strategy was an integral component of the VERB™ campaign. The intention behind the campaign was to become the children's brand for physical activity, effecting behavioural norms by positioning physical activity as a highly appealing and easy choice [67]. Survey based evaluations of VERB™ (n = 2257 to 3120) found it to be successful in its initial launch at increasing awareness [65] which was sustained up to 2 years after [64,67], and indeed appeared to positively influence children's physical activity behaviours over this period [64,67]. Using a brand is both an example of *promotion* in social marketing and *salience* in behavioural economics, as brands help to draw the attention of the audience and the adaptation of this intervention to wider diverse audiences (e.g. rural youth) has been explored [68].

Characters

Using characters to influence behaviour change was also a popular strategy; employing only characters as a method of influencing a child's behaviour was used by three studies included in this review [30,49,62] these had a mean quality score of 66.6%. Using characters is a demonstration of both social marketing and behavioural economics, from a social marketing perspective that are part of the *promotion* phase and from a behavioural economics perspective they are used as *messengers* to deliver the message, and the *affect* that children have for them is also played on. Longacre et al. (2015) using momentary time-sampling methods and coding of 804 children demonstrated that playful programming using fruit and vegetable based characters can engage children's interest. Both Letona et al. (2014) [49] and de Droog et al. (2014) [62] using experimental methods also show that characters can influences children's food choice behaviours with children more likely in both studies to choose foods with relevantly associated characters. Figure 4 also illustrates how the previously mentioned and successful VERB™ campaign used characters to promote physical activity to children (a full-page advertorial featuring the Marvel characters Wolverine and Nighcrawler). The feature compares the activities of normal kids with the characters superhuman skills stating that you don't have to be a hero to be active "Wolverines way or your way, it makes no difference how you play". Furthermore, this is also an example of entertainment-education, which revolves around embedding prosocial messages, such as the importance of physical activity, into popular media content [78]. By embedding the messages in popular media the aim is to positively influence awareness, knowledge, attitudes and/or behaviours [78].

Figure 4: VERB advertorial with Marvel

Framing the child's activities as superhuman skills can also be related to another area of research around engaging children: gamification. Gamifications underlying concept is motivation and it has been reported to be a promising new approach to behaviour change [79]. In one description of gamification the fictional world is said that lectures, tests and discussions are replaced with adventures, monsters and councils [80]. This can be compared to the Marvel advertorial where children are being encouraged to see their physical activity skills are superhuman skills. This highlights the potential benefits that may come with implementing elements of gamification and/or entertainment education in a health-related behaviour change intervention targeting children.

Using characters is popular because they use the positive feelings that a child has towards their favourite characters in the hope that they will then have positive feelings towards the advertised product/behaviour. This demonstrates one of the behavioural economic key lessons put forward in the MINDSPACE acronym: Affect i.e. that emotions can shape our decisions. Children have pre-existing emotions towards these characters [19] and this is what is being exploited when they are used to influence a behaviour. It can also be said to link in with one of the P's of social marketing, *promotion*, as a character is used in the promotion of a product/behaviour. Further, research regarding parasocial interactions posits that after being exposed to a character for a long period of time children can feel that they know the character, sometimes as well as they know their own friends [81]; this is most clearly evidence in the study of de Droog et al. (2014) [62] where a rabbit character (as compared to a turtle) increased carrot consumption in children. As children often see characters as role models they will want to act in the same way as them, and in some cases children take on the role of the characters sharing their feelings, perspectives, and goals [78].

Media/technology

Eleven studies incorporated elements of the media/technology into their studies in the aim of influencing behaviour [72,35,46,40,52,41,44,50,58,77,57] with a mean quality score 72.2%. An example of using the media to advertise can be seen in a study by Dixon et al., (2007) [52] who conducted a pre-post controlled experimental study and found that greater exposure to junk food advertisement increased junk food intake in children. Similar results were reported by Velaquez et al., (2014) [32] who examined the eye movements of children watching advertisements in a cross-sectional study and concluded that those children who spent more time examining the unhealthy food advertisement reported greater preference for that food type. Two studies suggested that junk food advertisements can influence short-term behaviour in children, by influencing the preference for and intake of junk food [51,40]. Advertisements are used by marketers to promote their products, but they often also incorporate elements of behavioural economics; for example, the S in the MINDSPACE acronym relates to salience, people being drawn to new and prominent products/behaviours. Advertisements are often promoting new products/behaviours as a way to influence the audiences behaviour, again demonstrating the combined use of elements of these two strategies.

In addition to the effects that advertisements generally have on the food preferences, studies also investigated the effects of different types of advertisements. Hota et al (2010) [42] compared the effects of two different public service advertisements that aimed to influence children's attitude towards fruit consumption using a randomised control trial study design. One advertisement, deemed the *classic,* was created by the French government and was focused around a young girl, the other was an *animated* advertisement which used elves and a wizard. The researchers reported that both advertisements had a positive and significant influence over children's attitudes towards fruit. This may be due to the fact that behavioural economics posits that people are influenced by who delivers the message; in both advertisements the message was delivered in a child friendly way, either through a narrative with a girl or with the elves and wizard. As well as again demonstrating how social marketing and behavioural economic principles can be used holistically in an intervention, this research also supports that the benefits of using advertisements are not limited to promoting unhealthy foods, they can also be used in a positive way helping in the promotion of healthy foods. It also shows the combination of two of the methods of influencing behaviour, characters and media/ technology, six studies included in this review did this [51,63,38,42,55,47] mean quality score 73.3%.

Future research

This review has identified the combined presence of social marketing and behavioural economic strategies in a number of health based interventions aimed at children. Future research should use this as justification for the conceptual and practical amalgamation of the two research areas into one for the development, evaluation, and implementation of future interventions to increase their effectiveness. Furthermore, it has shown the influence that characters have over a child's engagement in a health related behaviour, and demonstrates the potential benefits that using characters can have. Many of the studies reported in the review have incorporated elements of both gamification entertainment education, and therefore this is suggested as an effective tool for future interventions to employ. Future studies should consider the use of this as an intervention for promoting positive health behaviours in children, for example promoting healthy nutrition or physical activity engagement. However, though some studies have made direct measurements of behavioural outcomes (as opposed to merely awareness, attitudes, and intentions), these are often limited to smaller lab based experimental designs. Future work should examine the evaluation with direct behavioural measures of intervention effectiveness when implemented in real world contexts.

The final point to raise is again to highlight the large number of papers which found using these strategies can change behaviour, 95% of these papers with behaviour change outcomes reported the strategies employed lead to behaviour change. Interestingly, the only two papers where no behaviour change was reported only adopted one of the three methods, either just using the media, or just raising awareness, and neither used characters. This may suggest that using a combination of approaches may be more beneficial, and also may suggests the positive influence that incorporating characters has on a child's behaviour. One limitation of this research which is worth noting is that a meta-analysis was not possible, due to the different outcome variables.

5.0 CONCLUSION

The findings from this review support the points raised by Dessart and Van Bavel (2017) [20] in demonstrating the clear links, overlaps and consistency in the research around both behavioural economic strategies and social marketing, particularly in their attempted use to influence the health behaviours of children. Furthermore, it highlights how both of these strategies have been used both positively, for example in promoting physical activity engagement, but also negatively, for example in the promotion of junk food. Both behavioural economic strategies and social marketing have been found to influence health related behaviours in children, as demonstrated by the research included in

this review; however, it is suggested that future interventions adopt the use of both strategies in a holistic way to best development, evaluate, and implement interventions found to be effective in positively influencing health behaviours in children.

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Table 2: Information for included papers

First Author, Year	Country	Sample age (years)	Sample size	Health behaviour	Positive/Negative behaviour	Study design	Quality Score	Characters	Awareness	Media/ technology	Summary	Behaviour Change
Economos 2007 [74]	USA	7.6 ± 1.0	178		+	Quantitative non randomized	80%		X		Investigated an environmental change intervention's ability to prevent weight gain in children, it reported reductions in BMI-Z scores in children at high risk for obesity.	✓
Anzman-Frasca 2017 [29]	USA	6-10	58		+	Quantitative Descriptive	60%		X		Assessed perspectives on children's meals in restaurants, findings will be used to inform the development of restaurant interventions that are effective in promoting healthy eating.	N/A
Borzekowski 2001 [51]	USA	2-4	46		-	Quantitative randomised	80%	X		X	Examined TV commercials influence over pre-schoolers food preferences, found that even brief exposures can influence their preferences.	✓
de Droog 2014 [62]	The Netherlands	4-6	160		+	Quantitative randomised	60%	X			Investigated whether and how a picture book promoting carrots can increase children's carrot consumption. The experimental group consumed nearly twice as many carrots as the control group.	✓
Dovey 2011 [63]	UK	5-7	66		+	Quantitative randomised cross over	80%	X		X	Explored the role of food neophobia in response to food TV adverts in children. Children with low levels of food neophobia responded well to the healthy adverts but the children with higher levels did not.	✓
Folta 2018 [28]	USA	8-10	17		+	Qualitative	100%		X		Aimed to develop a branding strategy to improve the quality of food children brought in from home, the formative research provided information to create the brand.	N/A
Ho et al., 2017 [72]	Singapore	9-12	345		+	Quantitative Descriptive	60%			X	Explored presence in exergames as a mechanism that may be associated with positive mood experiences. Digital health interventions like exergames are a promising tool for increasing physical activity levels in children.	✓
Huhman 2005 [64]	USA	9-13	3120		+	Quantitative Descriptive	80%	X	X	X	To determine the effects of a mass media campaign, high levels of awareness were reported showing that promoting physical activity with advertisements as a promising method.	N/A

Huhman 2008 [65]	USA	9-13	2729			+	Quantitative Descriptive	60%	X	X	X	Assess the immediate effects of a mass media campaign, prompted awareness of campaign was deemed high at 57%.	N/A
Longacre 2015 [30]	USA	4.7 ± 0.6	804			+	Quantitative Descriptive	60%	X			Investigated using an entertainment based approach to promote fruit and vegetable to children ,the children were highly engaged in the programming with the fruit and vegetables.	✓
Lopez 2017 [31]	USA	6-10	27			+	Quantitative Descriptive	80%	X	X		Pilot tested certain strategies to increase demand for the healthier meals for children at a restaurant, more research was suggested to build on these findings.	N/A
Velazquez 2014 [32]	USA	8-15	102			-	Quantitative Descriptive	60%		X	X	Examined attention to food and beverage advertising and how this was associated with preferences, positive association found between length of time looking at advertising and preference for that unhealthy food item.	✓
Williams 2014 [75]	USA	11-13	217			+	Quantitative non randomised	0%		X		Examined a childhood obesity initiative using a brand, concluded that commercial marketing strategies may be an effective strategy for obesity prevention in youth.	✓
Effertz et al., 2019 [33]	Russia	10-18	721			-	Quantitative Descriptive	80%		X	X	Investigated the relationship between brand marketing and taste experienced, strong and positive brand effects were reported for brands effects on children's satisfaction.	✓
Chambers et al., 2018 [34]	New Zealand	11-13	167			-	Quantitative Descriptive	100%		X		Examine children's exposure to alcohol marketing via packaging, children are frequently exposed to alcohol marketing meaning it is normalised in their environment	N/A
Emond et al., 2019 (a) [35]	USA	3-5	624			-	Quantitative Descriptive	80%			X	Investigated the influence of fast food advertising exposure on fast food intake, and the influence of parental fast food intake, . Advertisements for fast food may mitigate the protective effects if infrequent parental fast food intake on children's fast food intake	✓
Emond et al., 2019 (b) [36]	USA	4.3±0.8	624			-	Quantitative Descriptive	80%		X		Influence of food advertising and children's intake of the advertised cereal, brand specific high energy cereal advertisements were associated with consumption of these cereals.	✓
Beaufort 2018 [37]	Austria	3-5	80			-	Quantitative Descriptive	100%		X	X	Assessed how candy placements in films can influence children's selection behaviour in a shopping scenario, risk of selecting a placed product was more than nine times higher in the experimental compared to the control group.	✓
Andreyeva et al., 2011 [46]	USA	5	11820			-	Quantitative non randomized	100%			X	Investigated exposure to food advertising and children's fast food and soft drink consumption, results suggests that advertisements are associated with consumption in children.	✓

Berkowitz et al., 2008 [66]	USA	9-13	20818		+	Quantitative non randomized	80%	X	X	X	Study assessed the awareness and understanding of a mass media campaign, and found that by providing communities with a higher dose of marketing activities and sustaining those activities over time, there were more positive outcomes reported.	N/A
Huhman et al., 2007 [67]	USA	9-13	2257		+	Quantitative Descriptive	80%	X	X	X	Assessed physical activity behaviours and attitudes at baseline and 2 years post a mass media campaign, a dose response effect was detected.	✓
Bezbaruah and Brunt 2012 38]	USA	8-10	218		+	Quantitative Descriptive	60%	X		X	Investigate the influence of cartoon characters used in advertisement on children's fruit and vegetable preferences, the most influential factors were taste.	✓
Boyland et al., 2013 [47]	UK	8-11	181		-	Quantitative non randomized	80%	X		X	Study looked to determine whether exposure to a celebrity endorser can influence intake, results found that they have an influence over intake in or out of a food commercial context.	✓
Bruce et al., 2013 [39]	USA	9-16	20		-	Quantitative Descriptive	80%		X		Evaluated the bran activation in response to logos in healthy and obese children, were shown food logos obsess children had significantly less brain activation in the areas of the brain associated with cognitive control.	N/A
Buijzen et al., 2007 [40]	The Netherlands	4-12	234		-	Quantitative Descriptive	80%			X	Investigated food advertisement and consumption, it was found that the relationship between the two was present in lower income families.	✓
Colquitt et al., 2014 [68]	USA	8-13	12		+	Qualitative	100%	X	X	X	A study investigated adapting an intervention to fit a rural diverse community, results indicated that significant changes were needed for the program for a different audience.	N/A
Dixon et al., 2007 [52]	Australia	10-11	919		-	Quantitative randomised	80%			X	Compared food advertisement for junk food versus nutritious food, on children's food attitudes and preferences. There were positive findings for using advertisements to promote healthy foods.	✓
Keller et al., 2012 [53]	USA	4-6	43		-	Quantitative randomised	60%		X		Investigated the effects of branding on children's eating, found that banding in an important influencer over what and how much children eat.	✓
Harris and Kalnova 2018 [41]	USA	2-11	49		-	Quantitative Descriptive	60%			X	Measured the exposure and impact of food and beverage advertising to young children, the advertisement likely increases their preference for nutritionally poor food.	✓
Haryanto et al., 2016 [27]	Indonesia, Portugal & Brazil	5-14	47		-	Qualitative	100%		X		Research attempts to identify what antecedents are present for brand loyalty for children, and the findings help better understand children's buying behaviours in terms of the influence of brands.	N/A

Hota et al., 2010 [42]	France	8-11	143		-	Quantitative Descriptive	80%	X		X	Investigated public service announcements and their effects on children, child relevance was key as an antecedent for the effectiveness of pro nutrition messages.	N/A
Forman et al., 2009 [54]	USA	4-6	43		-	Quantitative randomised	60%		X		Compared the influence of branding between healthy weight and obese children, overweight children showed a greater responses to food branding.	✓
Matthes and Naderer 2015 [55]	Austria	6-14	126		-	Quantitative randomised	60%	X		X	Children's consumption behaviour in response to food placement in films, results showed that exposure to the high frequency product placement exerted a significant effect on snack consumption.	✓
Norman et al., 2018 [56]	Australia	7-12	160		-	Quantitative randomised	60%		X	X	Study aimed to determine the relationship between parental feeding practices and children's intake responses to food advertising exposure. There was a susceptibility to food advertising among children whose parents report controlling feeding practices.	✓
Norman et al., 2020 [57]	Australia	7-12	154		-	Quantitative randomised	60%			X	Investigated how exposure to different marketing techniques from TV) and online food advertising affects children's brand recall, recognition, and attitudinal responses toward brands and brand consumers and children's desire to eat the advertised products. The marketing communications increased children's brand recognition and elicited positive attitudinal responses.	✓
Uribe and Fuentes-Garcia 2015 [43]	Chile	9-15	483		-	Quantitative Descriptive	80%		X	X	Examined the effects of unhealthy food brand placement on children, both brand awareness and behavioural disposition towards junk food increased when children were exposed to marketing.	✓
Gunnarsdottir and Thorsdottir 2010 [48]	Iceland	3-6	66		+	Quantitative non randomized	80%	X	X		Investigated using popular brands to promote healthy eating, children have preference for child orientated wrapping and this could be a popular way to promote healthier eating among children.	✓
Letona et al., 2014 [49]	Guatemala	7.4±1.9	121		-	Quantitative non randomized	80%	X			Examined how licenced characters on food packages influenced children's taste and snack preferences, the inclusion of characters on food packaging influenced children's taste and snack preferences.	✓
Kelley et al., 2019 [44]	Australia	8-12	282		-	Quantitative Descriptive	80%			X	Explored children's emotional attachment to food and beverage brands and their food marketing exposure. Concluded that reducing children's exposure to unhealthy food and beverage advertisement is a must for governments.	N/A

Kent et al., 2019 [45]	Canada	5-18	154			-	Quantitative Descriptive	60%		X		Investigated current food marketing exposure to children's in schools and found that the current policies that should restrict marketing of unhealthy food to children is inadequate.	✓
Masterson et al., 2019 [50]	USA	7-9	41			-	Quantitative non randomized	80%			X	Compared healthy weight and overweight children's brand responses to food commercials, no effects of consumption but for overweight children there were differences in brain activity when viewing the commercials.	X
Smith et al., 2019 [58]	Australia	7-9	156			-	Quantitative randomised	60%			X	Study explored and contributed to the understanding around more modern techniques of food advertisements on children's food consumption.	N/A
Samek 2019 [59]	USA	5-11	1483			+	Quantitative randomised	60%		X		Investigated using behavioural nudges to positively influence nutritional choices in children, small unconditional gifts increased healthy choices in children.	✓
Miller et al., 2016 [60]	USA	10-12	71			+	Quantitative randomised	60%		X		Examined the effects of using nudges at school meal pre ordering, nudging during pre-ordering lead to more orders of fruit and vegetables.	✓
Sharps et al., 2019 [61]	UK	8.9±1.41	63			+	Quantitative randomised	80%		X		Investigated using pictorial nudges to promote healthier food for children, The results indicate that pictorial nudges on tableware influence children's fruit and vegetable consumption.	✓
Willi et al., 2012 [76]	USA	11-14	4363			+	Quantitative randomised	60%		X		Examined the effects of a schools based interventions aimed at reducing the risk factors associated with CVD, modest reductions were reported.	✓
Thomas et al., 2014 [73]	Australia	9-18	184			+	Qualitative	100%		X		Investigated the use of a social marketing campaign to reduce childhood obesity and concluded that a well-funded social marketing campaign can have an important role in the prevention and management of obesity.	✓
Gorely et al., 2011 [69]	UK	7-11	589			+	Mixed Convergent	80%		X		Investigated the effects if a school based intervention which had has positive outcomes reported at the time. However 18-20 months later there were no sustained positive changes.	X
Baranowski et al., 2011 [77]	USA	10-12	133			+	Quantitative randomised	60%			X	Investigated using video games to promote positive behaviour games, study reported that videos games with healthy messages embedded increased fruit and vegetable consumption	✓
Hardman et al., 2009 [70]	UK	10.6±0.7	32			+	Quantitative randomised	60%	X	X		Analysed a home based physical activity intervention aimed at girls using fictional role models. Those in the experimental groups were more active than those in the control.	✓

Sauvage-Mar et al., 2019 [71]	Canada	7-15	79		+	Qualitative	100%	X	Described the development of a social marketing campaign to promote active travel to school in female school children.	N/A